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INTENTIONAL INPUT OF ERRORS INTO THE MAINTENANCE DATA

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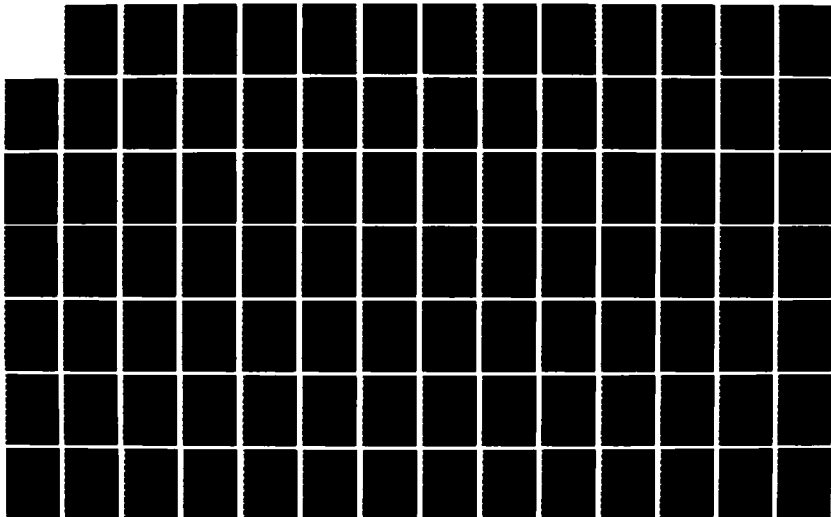
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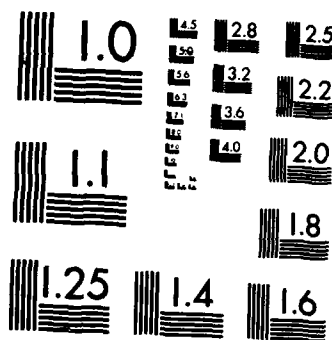
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MAINTENANCE DATA COLLECTION SYSTEM

THESIS

Thomas L. Folmar
Captain, USAF

AFIT/GLM/LSM/86S-22

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INTENTIONAL INPUT OF ERRORS INTO THE
MAINTENANCE DATA COLLECTION SYSTEM

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

Thomas L. Folmar, M.B.A.

Captain, USAF

September 1986

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Abstract

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This ~~research~~ attempted to quantify the perceived magnitude of intentional errors in the Maintenance Data Collection system data base and to determine the underlying causes for the reporting of inaccurate and invalid data. It was limited to the aircraft maintenance organizations within the Strategic Air Command and the Tactical Air Command. A stratified random sample was surveyed of all aircraft maintenance personnel of the rank of airman basic through colonel in the aircraft maintenance complex at the bases in these two commands within the continental United States.

Those surveyed indicated that nearly 10 percent of all data input is intentionally inaccurate. Over 85 percent of those surveyed felt that some of the data which is input inaccurately, is done so intentionally. The pressure to account for man-hour availability is the primary reason given for falsifying the MDC input. Ninety-two percent of the maintenance personnel surveyed admitted that they are pressured at least part of the time to manipulate the MDC input.

A recommendation was made for the leadership at all levels of the Air Force maintenance complex to re-evaluate their motives and methods for insuring maintenance

information is input into the MDC system. Furthermore, the information uncovered in this study indicates that further research should be conducted into the amount and types of data that need to be collected from Air Force maintenance organizations. The Air Force should consider a maintenance data collection system similar to that used by the U.S. Army (the Sample Data Collection system).

INTENTIONAL INPUT OF ERRORS INTO THE MAINTENANCE DATA COLLECTION SYSTEM

I. Introduction

General Issue

Maintenance data is required by management at all levels in the Air Force and the Department of Defense. This information is used, in part, to evaluate the performance of defense systems and their component parts, the effectiveness of maintenance programs and personnel and to determine weapon system operating and support costs (defined in Appendix A). Of growing importance is the fact that maintenance data is used in calculating the reliability (Appendix A) and maintainability (Appendix A) of weapon systems.

The Maintenance Data Collection (MDC) system is the primary means of obtaining base-level maintenance data. The MDC system collects and processes maintenance data on aircraft, missiles, certain communications-electronics equipment, and some of their support equipment. The data processed by the system consists primarily of man-hour expenditures and technical data related to maintenance tasks that have been accomplished. The data is documented manually on Air Force Technical Order (AFTO) Form 349,

collected, keypunched, and processed at the base level for compilation into reports and computer storage.

Information from the MDC system is used at the base-level to provide feedback to the managers who control the maintenance operation. The information is used in scheduling work, identifying work already accomplished, providing aircraft status information and monitoring direct and indirect labor (Appendix A) utilization. Many off-base organizations use MDC data provided by the various bases. The Air Force Logistics Command (AFLC) uses the data to validate parts requirements, to monitor aircraft and support equipment modifications and their effectiveness, to identify aircraft reliability and maintainability problems, and establish priorities for improvements to systems. AFLC, in addition, provides MDC data to other users. Aircraft contractors use the data to evaluate aircraft performance when developing new systems. Headquarters Air Force and major commands use the data to establish maintenance manning requirements. The Air Force Visibility and Management of Operating and Support Costs (VAMOSC) systems compute many base-level costs based on MDC data.

Problem Statement

There is a need to determine the accuracy and validity of the data input into the Maintenance Data Collection system. Additionally, if data is inaccurate or

invalid, there is a need to identify the underlying cause(s).

Justification

The need for maintenance data in the MDC system to be reported accurately, reliably, and in a timely manner is evident from the widespread use of the MDC data base. Estimates have been made by the Air Force that as many as 105,000 maintenance personnel are directly involved in documentation of maintenance actions at the base level. Since maintenance staffing accounts for one third of the total Air Force staffing expenditures, the cost of gathering the volume of data required by the MDC system is indeed staggering. Air Force officials estimate that the key-punch staff time alone uses 350,000 hours per year or the equivalent of 175 man-years. A report by the Commission on Federal Paperwork issued in 1976 stated that approximately four million man-hours are consumed to complete the nearly 80 million forms filed annually. This is the same as using 2000 people for an entire year just to document the maintenance that was performed. Furthermore, these estimates do not include the cost of the forms, punch cards, computer paper, computer time, computer programmers, or the numerous levels of review of inputs and outputs (1:1-3).

Errors are bound to occur in a system that is so manpower intensive in the collection and assimilation of information from throughout the Air Force maintenance

function. According to the Comptroller General, Air Force procedures for collecting data on maintenance activities are costly, paperwork intensive, and generally ineffective in providing complete, accurate, timely, and useful information to Air Force and Department of Defense decision-makers (1:1-23). If the Air Force could identify the underlying reasons why inaccurate or invalid data is being input into the MDC system, if in fact it is, steps could be taken that could result in a potentially much more useful data base which would enable managers to more closely identify manpower requirements, system problem areas, equipment reliability problems and other perplexing organizational problems.

Research Objective

This research attempted to quantify the perceived magnitude of intentional errors in the Maintenance Data Collection system data base and to determine the underlying causes for the reporting of inaccurate and invalid data.

Investigative Questions

1. Is inaccurate or invalid data intentionally input into the MDC system? If so, for what reason or reasons, how often, and to what extent?
2. What is the perceived value of the MDC information at the operating base level?

3. Are the findings consistent between workers, supervisors, and managers? Between major commands?

Scope and Limitations

Past research into the validity and accuracy of the MDC data base has relied on the assumption that personnel who input data into the system made every effort to ensure that they input accurate and valid data. The research concentrated on showing where unintentional errors were created during the complex coding and keypunching of the forms. This research effort focused on the possibility that personnel may intentionally input inaccurate and invalid data and the underlying reasons for their actions.

This research was limited to the aircraft maintenance organizations within the Strategic Air Command and the Tactical Air Command. These two commands were chosen because they are representative of the two major organizational structures used by Air Force major commands for their maintenance organizations. A stratified random sample was taken of all aircraft maintenance personnel of the rank of airman basic through colonel in the aircraft maintenance complex at the bases in these two commands within the continental United States. This provided a representative sample of the Air Force while providing a reasonable size sample frame from which to select participants for this research. This research was further limited to military personnel and did not address the input of

data into the system by Department of Defense civilians or contractors. The intent was to identify the magnitude of the problem and its underlying causes.

II. Background

The Maintenance Data Collection (MDC) System was implemented in 1958 as a means to collect, store, and retrieve base level maintenance production data. The MDC system is currently a punched card processing system used to record data concerning the maintenance of aircraft, engines, missiles, and communications-electronics equipment and their support equipment (2:1-1). Basically the system involves the collection and processing of data concerning numerous aspects of the maintenance function: what was worked on, when the work was accomplished, what actions were taken, when the discrepancy (Appendix A) occurred, what the discrepancy was, who repaired it, and how long the repair action took. All of this data can be retrieved in various formats, including punchcards, reports, and magnetic tapes, depending on the needs of the intended user.

Uses of MDC Data

The intended uses of the data contained in the MDC data base are delineated in Technical Order 00-20-2, The Maintenance Data Collection System. The data is intended to be used at the base where it was collected. Furthermore, the data is meant to be used off the base by the Office of Program Management Responsibility for Manpower [USAF/PRM

(Manpower)], the Accounting and Finance Center, the Air Force Logistics Command (AFLC), and the Major Commands (MAJCOMs) (2:1-3).

The base level maintenance production data is intended to provide feedback to managers and supervisors for controlling and coordinating the maintenance operation. This information comes in the form of various reports as described in Air Force Manual (AFM) 66-267 and the Base Level Inquiry System (BLIS) as described in AFM 171-114. The base level managers and supervisors have access to the following information:

- a. Production information about the type of work accomplished, the work center that did the work, and the equipment on which the work was accomplished.
- b. Equipment maintenance schedules and inventory information for maintenance actions that are required on a calendar basis.
- c. Productive labor and indirect labor hour expenditures in either detailed or summary form. This includes labor expended to support other organization or special projects.
- d. Equipment failures and discrepancy information. This information is available in composite form by type of equipment and for individual equipment items.
- e. Configuration [Appendix A] status accounting. This includes information about modifications that have been completed and those that have been partially completed. (2:1-3)

Base level supervisors and managers also have at their disposal information concerning the cost of maintenance. They can obtain this information from the Maintenance Cost System (MCS) of which MDC is an input. Figures concerning the dollar cost of civilian and military man-hours, broken down by categories of productive direct and

indirect hours, can be retrieved through the system. The cost figures can also be broken down to show the cost to maintain aircraft and engines for both on-equipment and off-equipment maintenance (Appendix A). This system also makes it possible for bases to take action to be reimbursed for transient maintenance performed on aircraft from other bases (2:1-3).

Beyond the base level, the data in the MDC system has a myriad of uses. The information contained in the MDC data base is input into various programs established by Air Force and MAJCOM manuals and regulations.

The Air Force Logistics Command, as overall logistics manager for Air Force systems and equipment, requires base level maintenance production data to accomplish its multi-dimensional mission. AFLC uses the data to:

- a. Identify maintainability and reliability problems on Air Force equipment.
- b. Establish priorities for product improvement.
- c. Account for modifications to Air Force equipment and evaluate the effectiveness of modifications.
- d. Validate inspections and time change requirements and validate inspection and time change intervals.
- e. Identify safety deficiencies and monitor their corrective actions.
- f. Validate or adjust calibration intervals.
- g. Validate spares requirements.
- h. Identify programmed depot maintenance requirements.
- i. Compile maintenance manhours per flying hour data.
- j. Evaluate unsatisfactory material reports and modification proposals from other commands or industry.
- k. Compute the cost for billing the Military Airlift Command and the Air National Guard for reimbursable depot level maintenance.

1. Determine Time Compliance Technical Order (TCTO) kit distribution requirements and TCTO rescission dates. (2:1-3 to 1-4)

The data provided by MDC is used extensively within AFLC to manage Air Force assets. Besides the internal uses of the data, AFLC compiles numerous reports as requested by Headquarters Air Force, the Departments of the Army and Navy, and the various MAJCOMs. Furthermore, AFLC compiles any necessary data for use in accident investigations by the Inspector General. AFLC also uses the data to prepare reports which are provided to industry on the performance and support requirements of the present Air Force equipment for use in the design and development of new equipment and systems (2:1-4 to 1-5).

Other users of MDC data include Headquarters USAF Accounting and Finance, who determine the cost of base level maintenance operations. Headquarters USAF/MPM and the MAJCOMs use the data in validating manpower requirements. The MAJCOMs also use the data to assess the state of equipment modifications (2:1-5).

Previous Research Efforts

In light of the widespread uses of the data contained in the MDC system, the need for accuracy in the data base is apparent. The magnitude of allowable inaccuracies varies by the intended use of the data. As an example, computing the service life of high-cost low-inventory items would require near 100 percent accuracy.

On the other hand, when determining inspection intervals for an end item with a high inventory, some reasonable margin of error can be tolerated. Inaccuracies in the data base can be adjusted for if their magnitude could be reliably predicted. The United States Government and the Air Force have conducted several studies over the years in an attempt to develop a means to assess the accuracy of the data. What follows is a summary of some of their findings.

In 1964, AFLC contracted for research to be conducted into determining factors involved in human errors in hand transcription of written data (3). These are the type of errors that occur when the forms that workers have filled out are collected and keypunched for input into the computer. The FMC Corporation performed an experimental human factors study from 1 April 1964 to 30 March 1965 in which two phases of experiments were conducted involving forty-eight subjects in each experiment. Equal numbers of men and woman, clerical and production workers, and people over forty and under thirty years of age participated. The first phase consisted of a large experiment in which error levels were calculated and compared among the various groups from the transcription of pure numeric and arrangements of alpha-numeric codes of lengths from three through twenty characters. The effects of length of work periods were also evaluated. The second phase of experiments comprised a total of four experiments. The subjects were

exposed to different arrangements of pure numeric codes in the first two experiments of this phase. In addition to the areas analyzed in phase one, error levels from transcription of codes in sequential and nonsequential order were also analyzed. The third experiment involved the testing of varieties of character grouping within numeric codes and varieties of response formats. In the fourth and final experiment, the participants in the study were split into four groups and exposed to varying type fonts and instructions. This was done to test methods to improve legibility in machine-printed and hand-printed characters.

The results obtained from this study showed that "generally the human factors of age and sex had a significant effect on accuracy in hand transcription" (3:3). It was found that older people were more accurate on pure numeric codes, young people were more accurate on alphanumeric codes, and women were more accurate than men. Furthermore, it was found that sex and occupation interacted throughout both phases of the study: "female production workers and male clerks were consistently more accurate than male production workers and female clerks" (3:4).

In 1978, the Air Force contracted for research to be conducted into determining the feasibility of developing a methodology for quantifying the accuracy of reported base level maintenance data. Desmatics, Inc., a firm specializing in applied research in statistics, mathematics, and

operations research, conducted a study from September to December 1978 (4). The scope of this study was limited to demonstrating:

. . . the feasibility of quantifying the accuracy of reported base-level maintenance direct labor hour (DLH) data by making independent observations of statistically sampled maintenance tasks and comparing them with the reported DLH data. (4:i)

The data used in this study was gathered at two Tactical Air Command bases using a stratified random sample to insure a representative sample of maintenance activities from the three shifts, days of the week, and the three maintenance squadrons. Independent observations were made of the start and stop times for 119 maintenance jobs and the size of the crew accomplishing each job. After collecting the samples of actual observations, the data collected was compared to the data reported through the MDC system and the Reporting Accuracy Factor (RAF) was calculated. The RAF is defined as "the ratio of the number of manhours reported to the number of manhours observed" (4:31).

Desmatics found in its study that the bases they sampled had a combined estimated reporting accuracy factor of 1.94 (4:35). This means that the maintenance personnel performing the assigned jobs were over-reporting the direct labor hour usage in accomplishing the jobs by a factor of nearly two. They went on to say that "in any event, there is overwhelming evidence that the DLH data reported on the AFTO Form 349 at both Langley and MacDill reflects

'inflation' of manhours" (4:35). In accomplishing this study, Desmatics had significant difficulties in matching the observed maintenance job that they recorded with the accounts of the work that the maintenance personnel performing the jobs reported. They found they could match less than half of their observations with reported jobs. In analyzing this, they hypothesized two possible explanations:

. . . (1) possible errors or changes made in reporting the data through the MDC channel could have prevented unique identification of the required maintenance tasks, and (2) although given maintenance tasks were performed, the cognizant personnel neglected to report those tasks on (AFTO) Form 349. (4:36)

Being able to match observed tasks with reported tasks was one of the key assumptions in conducting the Desmatics study. The failure in meeting this assumption meant that fewer usable observations could be obtained than had been anticipated. No attempt was made to delve further into why the matching could not take place.

In 1981-1982, the Comptroller General of the United States, upon request from the Committee on Government Operations of the House of Representatives, conducted a review of maintenance information activities within the Department of the Air Force (1). The objective of this review was to assess the uses and development of current and projected maintenance information systems in light of user's needs and the need to solve data accuracy problems. To reach this objective, the General Accounting Office used the following procedures:

. . . we reviewed maintenance data collection efforts at the base level within the Military Airlift Command. We interviewed officials and other responsible personnel in the Office of the Secretary of Defense and the Air Force who are involved in the collection and use of maintenance data, or in the development of alternative approaches to collecting maintenance data. We analyzed documents, contracts, records, reports, regulations, and related information concerning maintenance data. We reviewed past reports by GAO and the Air Force Audit Agency on Air Force maintenance information problems. We also reviewed and evaluated selected Air Force efforts and studies of ways to improve its maintenance information systems. (1:7)

Upon completion of the GAO review, the Comptroller General presented his findings in January 1983.

The GAO found that "Air Force maintenance information systems are not responsive to users because they are inaccurate, incomplete, and untimely" (1:8). They found that direct labor hours are being overreported and that the number of maintenance jobs performed are being underreported. They found that oftentimes jobs that are opened in the MDC system are never closed out. Furthermore, they uncovered evidence to indicate that of the maintenance data that gets reported on the AFTO Form 349, "at least one data element . . . is wrong 99 percent of the time" (1:13). The GAO went on to say that there is little, if any, incentive for personnel to accurately report maintenance data. The personnel that are supposed to report the data are unable to utilize the data in their jobs and are unaware of the other uses of the data throughout the Air Force because they do not receive feedback from the MDC system. "The base-level managers also lack the incentive to push

the mechanics for accurate MDC data because the data is difficult to access and use at the base level" (1:14).

In responding to the GAO report, the Air Force concurred with the findings but went on to state that many of the problems with the current MDC system will be solved with the implementation of the Core Automated Maintenance System (CAMS) (5). The new system should provide increased capabilities for collecting and processing maintenance data and overall improvements in data accuracy. The CAMS will simplify the procedures used when documenting and reporting the MDC data. The CAMS will make it possible for managers and mechanics to access the local data base from remote terminals located in their work centers and use the information in the performance of their daily jobs.

The various studies into quantifying the inaccuracies in the MDC data base have only taken a cursory approach into determining the amount of intentional input of inaccurate and invalid data and the underlying causes for these actions. Most studies conducted on MDC have assumed that the personnel tasked to make inputs to the system are making every effort to input only factual, accurate and valid data.

In surveying the literature for this study, no literature was found to suggest that the errors in the data base are caused by the intentional input of inaccurate or misleading information. This research study is an

attempt to break new ground in determining the probable causes for the inaccuracies in the current MDC system. What follows is a brief summary of some studies made into the area of integrity in the military.

Integrity

In an open letter to commanders throughout the Air Force on 13 October 1972, General John D. Ryan, at the time USAF Chief of Staff, expressed his views on the need for integrity in the military:

Integrity--which includes full and accurate disclosure--is the keystone of military service. Integrity in reporting, for example, is the link that connects each flight crew, each specialist, and each administrator to the commander-in-chief. In any crisis, decisions and risks taken by the highest national authorities depend, in large part, on reported military capabilities and achievements. In the same way, every commander depends on accurate reporting from his forces. Unless he is positive of the integrity of his people, a commander cannot have confidence in his forces. Without integrity, the commander-in-chief cannot have confidence in us.

Therefore, we may not compromise our integrity--our truthfulness. To do so is not only unlawful but also degrading. False reporting is a clear example of a failure of integrity. Any order to compromise integrity is not a lawful order. . . . (6:1)

General Ryan clearly points out that incomplete or inaccurate reporting is a "failure of integrity."

The reasons why military personnel would sacrifice their integrity through the reporting of inaccurate or misleading information are as diverse as the individuals themselves. A study into the pressures on individuals to compromise their integrity was conducted in December 1982

by three officers attending Air Command and Staff College at Maxwell AFB, Alabama. The purpose of their study was

. . . to determine (1) why and in what circumstances USAF line officers and senior NCOs feel pressured to compromise their integrity, and (2) gather specific examples of incidents where respondents felt pressure to compromise. (7:vii)

A total of 1177 surveys were distributed with a response rate of 64 percent which allowed for a confidence level of 95 percent that the results accurately reflect the feeling of the population.

The results of the survey showed that there is widespread pressure to breach individual integrity. They found that 76.3 percent reported that they had been pressured at least once to compromise their integrity while in the Air Force (7:12). Sixty-five percent of those who had felt the pressure to compromise had succumb to that pressure at least once (7:13). The largest single category reported for which breaches of integrity had occurred was in the area of "false reporting." Over 42 percent admitted breaches involving the "pencil whipping" of reports, program requirement, and tests. The reasons given most often for their actions were: "career protection, making the organization look good, covering for the boss (making him/her look good) and getting the job done in spite of the regulations" (7:viii).

Integrity, as defined by Webster, is:

An uncompromising adherence to a code of moral, artistic, or other values: utter sincerity, honesty,

and candor: avoidance of deception, expediency, artificiality or shallowness of any kind. (8:1174)

But the study mentioned earlier seems to support what Lieutenant Colonel Merlin C. Smith wrote ten years earlier in 1973. Colonel Smith put forth the contention that a more appropriate working definition of integrity in the Air Force would appear like this:

An almost uncompromising adherence to a code of moral, artistic, or other values: when appropriate; utter sincerity, honesty, and candor: normally; avoidance of deception, expediency, artificiality or shallowness of any kind. (9:1)

This different meaning of integrity seems to have taken root in the Air Force establishment. The study which follows is an effort to identify some of the "false reporting" and to identify the underlying reasons for these "breaches of integrity" occurring.

III. Methodology

Introduction

In attempting to solve the problem defined in this research effort, a means to find the answers to the investigative questions had to be developed. After reviewing the past studies in this area and literature related to these types of problems, the prescribed procedures were devised and developed. This chapter shows the specific steps that were used in determining appropriate answers to the investigative questions stated in Chapter I:

1. Is inaccurate or invalid data intentionally input into the MDC system? If so, for what reason or reasons, how often, and to what extent?
2. What is the perceived value of the MDC information at the operating base level?
3. Are the findings consistent between workers, supervisors, and managers? Between major commands?

The Research Question

In attempting to achieve the first part of the objective of this research effort, ". . . to quantify the perceived magnitude of intentional errors in the Maintenance Data Collection system data base . . . ," the following statement was proposed: Maintenance personnel perceive that completely accurate data is input into the Maintenance

Data Collection system. The research data to be collected must show that this statement is incorrect or else there would be little reason to pursue this research further. If the data does disprove this statement, then further analyses would be required to establish the level of inaccurate data which maintenance personnel felt is intentionally input into the system. An analysis of the reasons for the intentional input of inaccurate and invalid data was required to fully achieve the second part of the research objective. The remainder of this chapter presents the steps that were used in developing the research methodology and the means used to analyze the data gathered.

The Survey Instrument

To answer the investigative questions posed earlier, a method of data collection had to be developed. The observational data collection process, as used by Desmatics in 1978 (4), was rejected as a possible means of collecting the data due to the cost and time constraints faced in conducting this type of research. The observational data collection process requires the researcher to monitor and record information about subjects without actually questioning them. The survey data collection process was chosen as the best possible means of obtaining the required information.

The survey data collection process can be accomplished by two basic means--the interview or the written

questionnaire. The written questionnaire was chosen as the means for conducting this survey because it has the following advantages over the interview: (1) lower costs, (2) better (larger) samples, (3) standardization, and (4) privacy (11:25). The written survey costs less in both time and money to conduct because numerous people can be surveyed at the same time and the cost of postage would generally be much less than the travel or telephone expenses involved in conducting an interview. Better samples can be obtained because more people can be reached within the budget constraints due to the lower costs involved. Better standardization is achieved because all respondents receive the exact same questionnaire whereas with an interview, the questions may be asked in a different order and with varying degrees of explanations. The last advantage considered was anonymity. Although never fully proven, most surveyors feel respondents will answer more honestly and openly if they feel their answers are anonymous (11:26). For this reason, complete anonymity was granted to respondents. Although the advantages of the written questionnaire showed it to be superior to the interview for this research effort, several disadvantages also had to be considered.

The three primary disadvantages of the questionnaire that had to be considered were nonreturns, misinterpretation, and validity problems (11:26-28). The nonreturn of surveys by respondents is an important consideration

because nonresponse is not a random process. The reasons for nonresponse have their own determinants which must be considered. This problem was addressed by keeping the survey as short as possible so respondents would not see it as a burden on their busy schedules. Pre-addressed postage paid return envelopes were included in the survey package to ease the return of the completed surveys. Misinterpretation was dealt with by keeping the questions as simple and forthright as possible while still covering the necessary points. Validity problems were dealt with by addressing the questionnaires directly to individuals with a cover letter explaining the importance of answering the questions to the best of their knowledge. The questionnaire method of sample data collection was chosen because of its advantages over the interview method while all efforts were made to minimize the disadvantages.

To obtain the data necessary to answer the investigative questions, a survey questionnaire was developed to gather the opinions of maintenance personnel. A copy of the survey is included in Appendix B. The survey was designed to achieve the research objective while retaining complete anonymity for the respondent. This was done so that the respondents would feel free to answer the questions openly and honestly without fear of any adverse actions being taken against them for their opinions.

The survey document was composed of nineteen questions. The survey was limited to relatively few questions in hopes that it would result in an improved response rate. The questions were broken down into three general sections--background information, multiple choice questions, and open-end questions.

The first four questions of the survey were designed to collect the information necessary to describe certain demographic characteristics of the study group. The information as to the respondent's major command, rank, and experience in an aircraft maintenance career field was collected for use in categorizing the responses to several of the questions. Investigative question 3 was answered by correlating the answers given by workers, supervisors, and managers. Further correlations were made to determine if results were consistent between TAC and SAC, both overall and by the categories previously mentioned. Question 3 of the survey, "Your current duty title is _____," was asked as a means of possibly giving increased credence to responses to the essay questions. A person that is working in a position of responsibility that routinely works directly with individuals inputting data to MDC could probably reflect more accurately on the reasons for those persons' actions than could someone not intimately familiar with those inputting the data. The question was made

optional to allow individual respondents to skip it if they felt it would identify them specifically.

The multiple choice questions were composed of various types. Questions 5 through 9 called for Likert scaled responses. These questions are designed to measure the intensity of the respondents' feelings on the subject in question (11:29-30). The answers covered a range of feelings from "strongly agree" to "strongly disagree." A variation of this answer scale was used on questions 10, 11, 13, and 14. These questions required the respondent to rate how often certain actions took place. The answers had a range from "always" to "never" on questions 10 and 11 and a range of "0 %" to "100 %" on questions 13 and 14. Questions 12 and 15 were closed-end questions in which the respondent was asked to choose the answer or answers that best answered the question.

The remainder of the survey, questions 16 through 19, was comprised of open-ended questions. This type question was chosen to allow respondents to answer questions in their own words. This further enabled respondents to express their feelings concerning ways to improve the current MDC system and to expand on possible reasons why individuals might intentionally falsify inputs into the system.

Answering the Investigative Questions

The investigative questions were answered through a combination of statistical and qualitative analyses of the

responses to the survey questions that applied to each. What follows is a discussion of how each investigative question was analyzed.

Investigative Question 1

Is inaccurate or invalid data intentionally input into the MDC system? If so, for what reason or reasons, how often, and to what extent?

The first part of this investigative question was to be answered by examining the responses to questions 11, 12, 13, and 14. Question 11 on the survey states: "Maintenance personnel are pressured by superiors to manipulate the MDC input." Responses to this statement range from always to never. The mean response was to be computed to show a consensus of the personnel in TAC and SAC as to how often they feel pressured to manipulate the data they enter in the system. This was accomplished by the SPSSX statistical software on the AFIT Academic Support Computer. The mean and the standard deviation were calculated as a means of showing how "grouped" the responses were. Question 12 states: "The majority of inaccurate and invalid data that is input to the MDC system is caused by: (1) Key punch errors; (2) Errors in filling out 349's; (3) Manipulation of the input to meet expectations; (4) Computer malfunctions; (5) Other (Please specify)." The modal response to this question showed what those surveyed felt was the primary source of inaccurate and invalid data in the MDC

system. Question 13 asks the following question: "In your opinion, what percentage of the data input into the MDC system is accurate concerning maintenance actions that occurred?" The mean and standard deviation were calculated from the responses to this question to determine the perceived magnitude of the input of accurate data. Question 14 asks: "Of the data that is input into the MDC system that is inaccurate, what percentage of that inaccurate data is intentionally inaccurate?" Once again, the mean and standard deviation were calculated to determine the perceived magnitude of the intentional input of inaccurate data.

The second part of this investigative question was answered through an analysis of the responses to questions 8, 10-14, and 17-19. Questions 11-14 were analyzed as stated previously. The mean response to question 8 gave an indication of the likelihood that inaccurate data is input to the MDC system due to the difficulty in accurately coding the information on the AFTO Form 349. The mean response to question 10 showed how often respondents felt that maintenance personnel attempt to input correct and valid data to the MDC system. Question 17 is an open-ended question that asked those surveyed to write out what they felt was the most prevalent reason for errors occurring in the MDC data base. The answers to this question were reviewed to see if a consensus exists on this question and also to see if any additional problems with the system can be uncovered.

Question 19 asked the respondent to specify the type of data on an AFTO Form 349 that is most often reported in error. The responses to this question were summarized and reviewed to determine if a consensus exists on this subject. Question 19 asks those surveyed to list the three most common reasons for false data being intentionally input into the MDC system.

Investigative Question 2

What is the perceived value of the MDC information at the operating base level?

This question was to be answered through an analysis of the responses to survey questions 5, 6, 7, 9, 15, and 16. The responses to this series of questions were to show what maintenance personnel feel is both good and bad about the MDC system and what they felt needs to be changed, if anything, to make it a better, more useful management tool. The mean of the responses to question 5 were to tell to what extent the respondents feel that the MDC system provides valuable feedback for base-level maintenance managers. Question 6 was to give an indication of whether the MDC system provides timely feedback to base-level maintenance managers. Once again the mean of the responses was to be used to obtain a consensus of opinion. The mean of the responses to question 7 was to show the level at which personnel feel the MDC system provides an accurate accounting of man-hour utilization in the maintenance complex. The

mean response to question 9 was to indicate whether people feel the MDC system is a useful management tool which should be retained by the Air Force. The modal response(s) to question 15 was to sum up in a few words how people would describe the present MDC system. Question 16 is an open-ended question that gave people the opportunity to express what they feel could be done to improve the MDC system, if anything. The responses to this question were to be summarized to show how maintenance personnel feel the system could be improved upon.

Investigative Question 3

Are the findings consistent between workers, supervisors, and managers? Between major commands?

This investigative question was to be answered by correlating the responses to most of the questions on the survey. Analysis of variance using a completely randomized design was to be used to determine if the means are significantly different for the subgroups at a .05 level of significance.

Analysis of variance (ANOVA) is a statistical technique commonly used to test the null hypothesis that the mean of several populations is equal (4:110). In this study, the test was to be made to determine whether or not the mean responses to many of the survey questions are equal in the various populations sampled: SAC workers, SAC supervisors, SAC managers, TAC workers, TAC supervisors,

TAC managers. The completely randomized design was used for comparing the means of k populations, from which were selected independent random samples from each of the k populations (15:630).

The ANOVA technique separates the observed variability in the data into two groups--variability of the group means and variability of the observations within a group about the group mean. The Mean Squared Error (MSE) between groups is divided by the MSE within groups to come up with what is known as the F statistic. The test relies on the following assumptions:

1. All k population probability distributions are normal.
2. The k population variances are equal.
3. Samples are selected randomly and independently from the respective populations. (15:634)

If the calculated F is greater than the F value for the given level of significance, based on $(k - 1)$ numerator degrees of freedom and $(n - k)$ denominator degrees of freedom, where n is the total observations within a given sample, then the null hypothesis can be rejected in favor of the alternative hypothesis that the means do in fact differ.

The Sample Plan

Upon choosing the mail survey questionnaire as the data collection instrument, the sample frame from which to choose those to be surveyed had to be determined. The decision was made that those people currently assigned to

maintenance positions would have the most current experience with the Maintenance Data Collection system on which to base their opinions. Furthermore, the scope of the research was limited to all bases within the continental United States with maintenance units of the Strategic Air Command and/or the Tactical Air Command. The sample frame was not limited any further to allow for differences between individual maintenance units.

To be able to accomplish a complete analysis of the responses, a stratified random sampling method was chosen. This method increases a sample's statistical efficiency when compared to a simple random sampling method (10:76-77). This occurs because each stratum is internally homogeneous and at the same time heterogeneous with all other strata. A second reason this method was chosen was because it would provide sufficient data for analyzing subgroups within the population. This is especially important for answering investigative question 3.

A total of six strata were chosen on which to conduct the survey. The strata were airman basic through staff sergeant (workers), technical sergeant through chief master sergeant (supervisors), and second lieutenant through colonel (managers). These three strata were each selected individually from SAC and TAC. The sample frame consisted of the numbers of personnel shown in Table I. These figures were obtained from Headquarters Air Force Manpower

TABLE I
SAMPLE FRAME

	Strategic Air Command	Tactical Air Command
Workers	17,629	31,026
Supervisors	5,629	8,918
Managers	<u>745</u>	<u>933</u>
TOTALS	24,003	40,877

and Personnel Center, Randolph AFB, Texas; Headquarters Strategic Air Command, Offutt AFB, Nebraska; and Headquarters Tactical Air Command, Langley AFB, Virginia. These figures were used in calculating the appropriate sample size for each strata.

For the purposes of this research, a 90 percent confidence interval was chosen as a basis for selecting the sample size. The following formula was obtained from the Air University's Sampling and Surveying Handbook and was used to calculate the sample sizes:

$$n = \frac{N \times Z^2 \times .25}{[d^2(N-1)] + (Z^2 \times .25)}$$

where

n = sample size needed

N = total population size

d = precision level (.10)

Z = based on 10 percent confidence interval

In determining the number of individuals to sample, an additional consideration was required beyond the initial calculations. A discussion with Dr. Charles R. Fenno, Associate Professor in the Department of Communication and Research Methods at the Air Force Institute of Technology, revealed that the usual response rate to expect on a survey of Air Force personnel was 50 percent. Furthermore, he stated that when surveying the junior enlisted force, a 40 percent response rate was about all that could be expected. Based on this discussion, an upward adjustment was made to the figures calculated with the formula mentioned previously. The adjustment was made by multiplying the required sample size for junior enlisted (workers) by 2.5 and all others were multiplied by 2. The total number of surveys which had to be mailed to obtain an appropriate sample size was calculated and shown in Table II. The actual personnel selected to participate in this survey were selected at random from the ATLAS Database (Appendix A). Selection was made based on the individual's MAJCOM, AFSC and the last one or two digits of his Social Security number.

TABLE II
NUMBER SURVEYED

	Strategic Air Command	Tactical Air Command
Workers	170	170
Supervisors	134	136
Managers	<u>126</u>	<u>128</u>
TOTALS	430	434

Survey Validation

The survey validation process takes place to ensure the survey will accomplish its intended purpose. The survey instrument used in this research was validated through a pretest of the survey and through the formal survey approval channels at AFMPC.

The pretest of the survey was conducted on fifteen personnel of the 4950th Organizational Maintenance Squadron at Wright-Patterson AFB, Ohio. This group was chosen because it was representative of the populations to be surveyed in the research while at the same time it was not a part of any of the research populations that would be studied. One purpose of the pretest was to see how well the cover letter would motivate the respondents and to determine if the instructions and questions would be clearly understood. Furthermore, the pretest was used to determine if the questions would actually solicit the answers needed

to solve the investigative questions. Based on the results of the pretest, minor modifications were made to the survey instruction sheet and to survey questions. These modifications were made to clarify what was being asked of the respondent and did not change the basic contents of the questions.

Upon completion of the pretest, the survey package was forwarded to Dr. Robert B. Weaver, AFIT/LS survey control officer, for processing to AFMPC/DPMYOS. This office at AFMPC is responsible for screening surveys to ensure they are in compliance with the regulations and that they are not duplicating work accomplished already by a previous survey. The survey was approved on 25 Mar 1986, with minor changes, by AFMPC and was given Survey Control Number (SCN) 86-41. This SCN is valid until 31 Dec 1986. Upon approval, the survey was reproduced and prepared for mailing.

Data Presentation

The survey results were coded and loaded into AFIT's Academic Support Computer (ASC) system. All data entered into the ASC can be found in Appendix C. The data was processed and prepared for presentation using the SPSSX statistical software package (13; 14). The data collected is presented in Chapter IV through a series of tables and graphs.

The demographic data from the returned questionnaires is shown in Table III. The results from the Tactical Air Command will be displayed in the same manner.

TABLE III
RETURN RATE OF SURVEY RESPONDENTS BY RANK (SAMPLE)

Rank	Number Distributed	Number Returned	Percent
Strategic Air Command			
Airman Basic through Staff Sergeant			
Technical Sergeant through Chief Master Sergeant			
Officer	_____	_____	_____
TOTAL			

To display the data gathered by the multiple-choice questions, a series of tables were constructed to show the mean and standard deviation of respondent replies to questions 5 through 11, 13, and 14. These tables show if any statistically significant difference exists (at a 95 percent confidence level) between the personnel in the two commands surveyed and also between the three rank groupings surveyed. Samples of these tables are shown as Tables IV and V.

Histograms were constructed to reflect the respondents' replies to questions 12, 15, and 18, as shown in Figure 1.

TABLE IV
MEAN LEVELS OF ANSWERS (SAMPLE)

Question Number	Question	Mean	Std Dev
Level of Agreement			
5	MDC provides valuable information for base-level maintenance mgrs.		
6	MDC provides timely feedback for base-level maintenance mgrs.		
7	MDC provides accurate accounting of man-hour utilization.		
8	Inaccurate data is input due to difficulty in coding the 349s.		
9	MDC is a useful management tool which should be retained by the AF.		
Likelihood of Occurrence			
10	Correct and valid data is input into the MDC system by maint. personnel.		
11	Maintenance personnel are pressured by superiors to manipulate the input.		
Accuracy of Input			
13	What percentage of the data input in the MDC system is accurate concerning maintenance actions that occurred?		
14	What percentage of the data input in the MDC system is intentionally inaccurate concerning maintenance actions that occurred?		

TABLE V
ANSWERS COMPARED BY SUBGROUP (SAMPLE)

Question Number	Overall Mean	SAC	TAC	SG ¹	SG ²	SG ³	Comments ⁴
Level of Agreement							
5							
6							
7							
8							
9							
Likelihood of Occurrence							
10							
11							
Accuracy of Input							
13							
14							

¹Subgrouping of officers.

²Subgrouping of technical sergeant to chief master sergeant.

³Subgrouping of airman basic to staff sergeant.

⁴a:
b: EXPLANATIONS OF
c: STATISTICALLY SIGNIFICANT
d: DIFFERENCES WILL
e: GO HERE

NOTE: Differences calculated for .05 level of significance.

QUESTION NO. This is a sample of the histogram format.

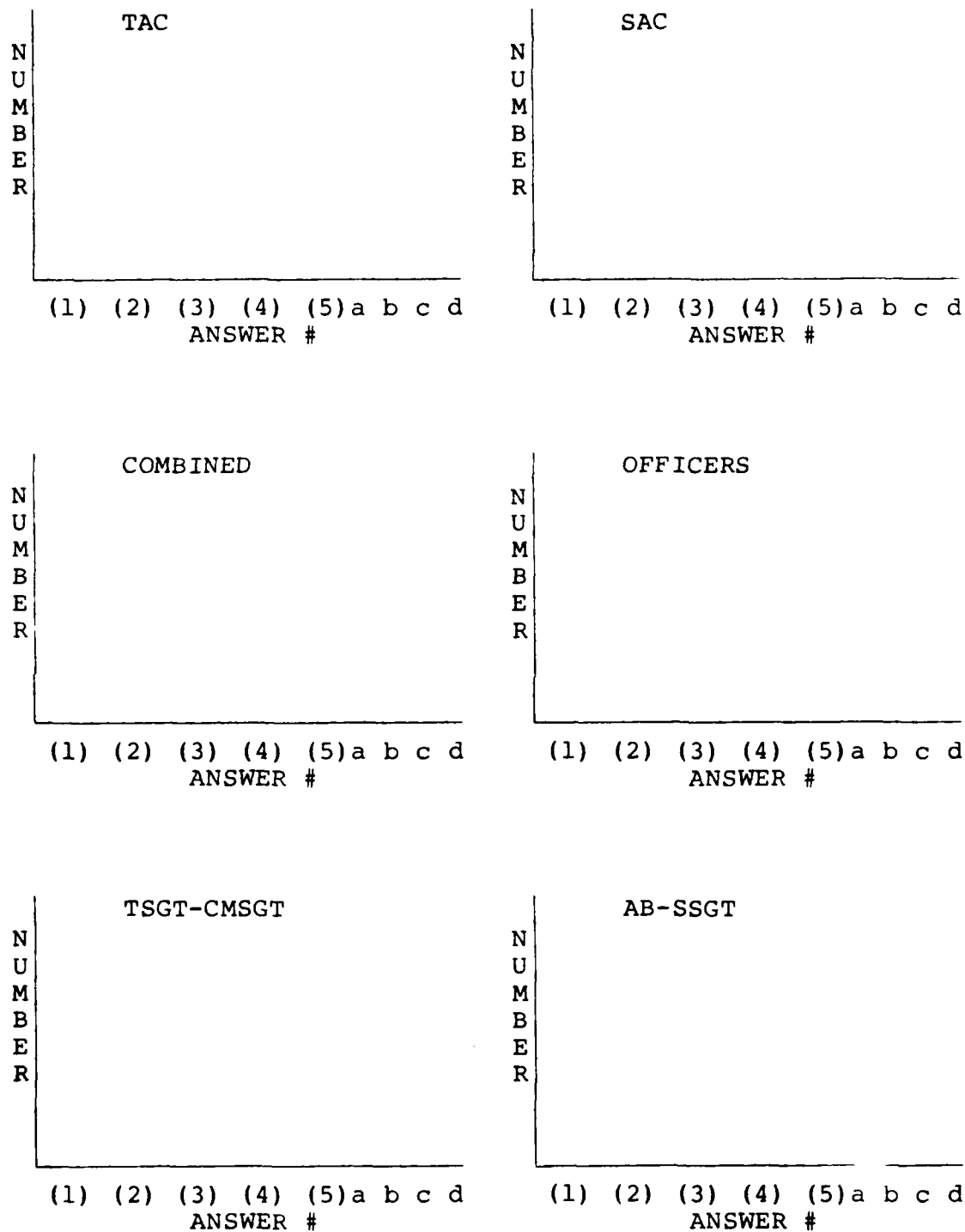


Fig. 1. Sample Histogram Format

The replies to the open-ended questions 16, 17, and 19 were summarized and condensed into a synopsis of how the respondents felt on the various questions.

Summary

The methodology described in this chapter was used to develop the research question, determine the sample plan, and to design and develop the survey. Furthermore, the data was transformed and analyzed in an effort to adequately answer the investigative questions. The chapters which follow contain a presentation of those results and findings, and the conclusions that were drawn from the data.

IV. Findings

The survey questionnaire was distributed on 17 April 1986 to personnel stationed at bases through the continental United States in the Strategic Air Command and the Tactical Air Command. Respondents were requested to complete and return the surveys as soon as possible, but not later than 23 May 1986. This chapter summarizes those results.

The survey results were manually coded and loaded into AFIT's Academic Support Computer (ASC) system. The data was processed and prepared for presentation using the SPSSX statistical software package. The data collected will be presented through a series of tables and graphs.

Demographic Data

The demographic data from the returned questionnaires is presented in Tables VI and VII.

TABLE VI
RETURN RATE OF SURVEY RESPONDENTS BY MAJOR COMMAND

MAJCOM	Number Distributed	Number Returned	Percent
Tactical Air Command	434	249	57.37
Strategic Air Command	<u>430</u>	<u>256</u>	<u>59.53</u>
TOTALS	864	505	58.45

TABLE VII
RETURN RATE OF SURVEY RESPONDENTS BY RANK

Rank	Number Distributed	Number Returned	Percent
Strategic Air Command			
Airman Basic through Staff Sergeant	170	77	45.29
Technical Sergeant through Chief Master Sergeant	134	96	71.64
Officer	<u>126</u>	<u>83</u>	<u>65.87</u>
TOTAL	430	256	59.53
Tactical Air Command			
Airman Basic through Staff Sergeant	170	73	42.94
Technical Sergeant through Chief Master Sergeant	136	100	73.53
Officer	<u>128</u>	<u>76</u>	<u>59.38</u>
TOTAL	434	249	57.37

Multiple-choice Questions

A series of tables have been constructed to show the mean and standard deviation of respondent replies to questions 5 through 11, 13, and 14. These tables (Tables VIII and IX) show if any statistically significant difference exists (at a 95 percent confidence interval) between the personnel in the two commands surveyed and also between the three rank groupings surveyed.

Histograms were constructed to reflect the respondents' replies to questions 12, 15, and 18 and are shown in Figures 2, 3, and 4.

Open-ended Questions

The open-ended questions produced a range of answers which varied in length from a single word to several paragraphs. The results were summarized and condensed into the following answers to questions 16, 17, and 19.

Question 16 asked: "If it were in your power to change the MDC system, what changes would you make and why?" Most responses to this question fell into several general categories. What follows is a brief synopsis of those categories in descending order from those with the most responses to the least.

The change which most respondents felt was most needed was to replace the present MDC system with the new Core Automated Maintenance System (CAMS). Those responding

TABLE VIII
MEAN LEVELS OF ANSWERS

Question Number	Question	Mean	Std Dev
Level of Agreement			
5	MDC provides valuable feedback for base-level maintenance mgrs.	2.615	1.034
6	MDC provides timely feedback for base-level maintenance mgrs.	3.051	1.067
7	MDC provides accurate accounting of man-hour utilization.	3.636	1.086
8	Inaccurate data is input due to difficulty in coding the 349s.	2.662	1.062
9	MDC is a useful management tool which should be retained by the AF.	2.885	1.130
Likelihood of Occurrence			
10	Correct and valid data is input into the MDC system by maint. personnel.	2.540	.739
11	Maintenance personnel are pressured by superiors to manipulate the input.	3.123	.969
Accuracy of Input			
15	What percentage of data input in the MDC system is accurate concerning maintenance actions that occurred?	7.354	2.028
16	What percentage of the data input in the MDC system is intentionally inaccurate concerning maintenance actions that occurred?	3.520	2.458

TABLE IX
ANSWERS COMPARED BY SUBGROUP

Question Number	Overall Mean	SAC	TAC	SG ¹	SG ²	SG ³	Comments ⁴
Level of Agreement							
5	2.615	2.60	2.63	2.73	2.68	2.41	a
6	3.051	3.00	3.10	3.37	3.04	2.73	a
7	3.636	3.58	3.70	3.75	3.73	3.39	a
8	2.662	2.66	2.66	2.72	2.69	2.55	-
9	2.885	2.85	2.92	2.95	3.03	2.64	a
Likelihood of Occurrence							
10	2.540	2.46	2.62	2.61	2.63	2.35	b
11	3.123	3.16	3.08	3.29	2.99	3.11	a
Accuracy of Input							
15	7.354	7.45	7.25	7.64	6.93	7.61	a
16	3.520	3.46	3.59	3.03	3.74	3.77	a

¹Subgrouping of officers.

²Subgrouping of technical sergeant to chief master sergeant.

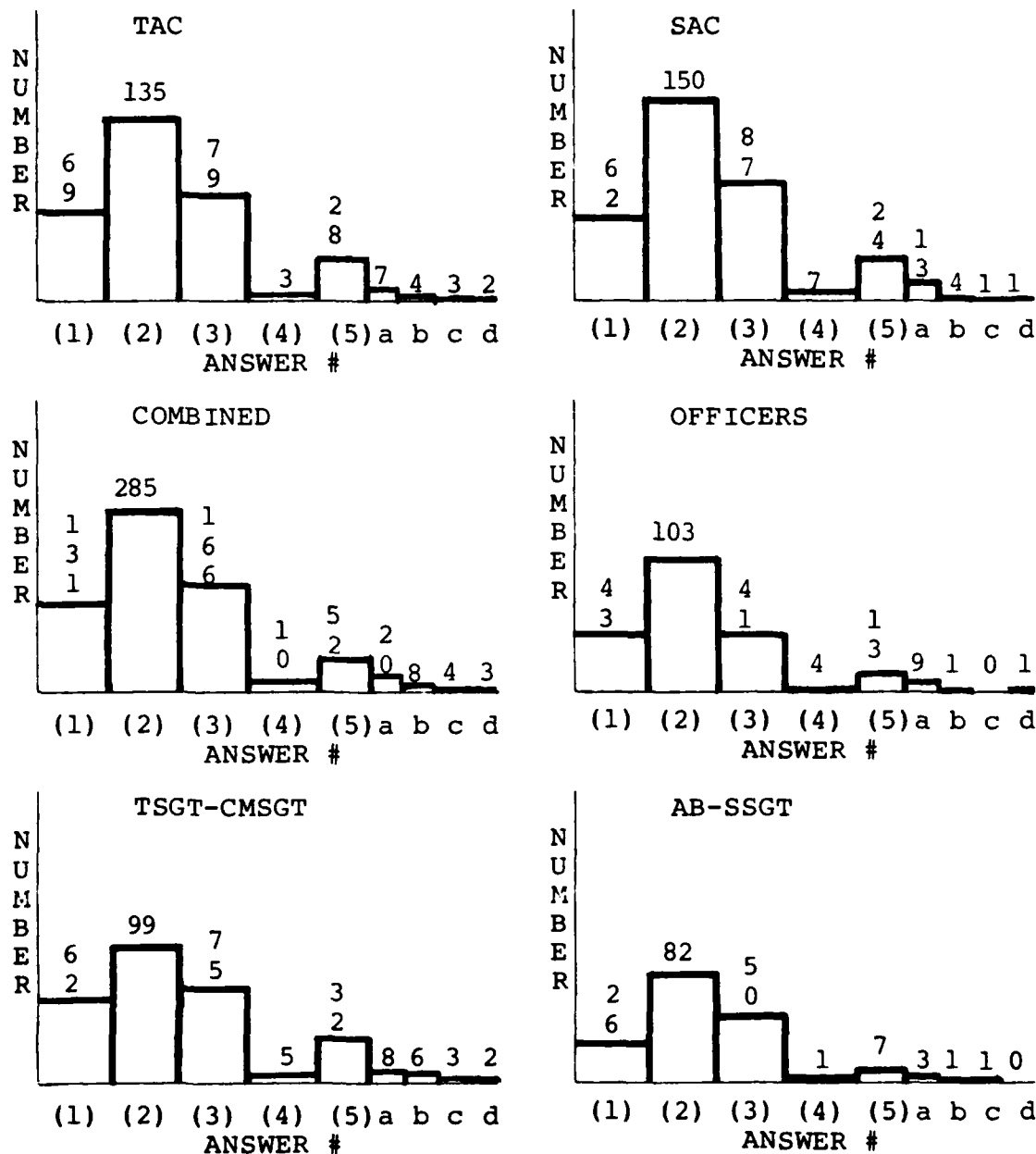
³Subgrouping of airman basic to staff sergeant.

⁴a: The means differ depending on rank.

b: The means differ depending on MAJCOM and rank separately, but not interactively.

NOTE: Differences calculated for .05 level of significance.

QUESTION 12. The majority of inaccurate and invalid data that is input to the MDC System is caused by:



- a) Personnel do not take the time to do the paperwork correctly or are given insufficient time.
- b) Not enough information in the -06 Work Unit Code manual.
- c) Pressure to account for 100 percent of available man-hours.
- d) Poor penmanship resulting in keypunch errors.

Fig. 2. Histograms of Responses to Question 12

QUESTION 15. Which of the following words best describe the present MDC System: (Choose only one response)

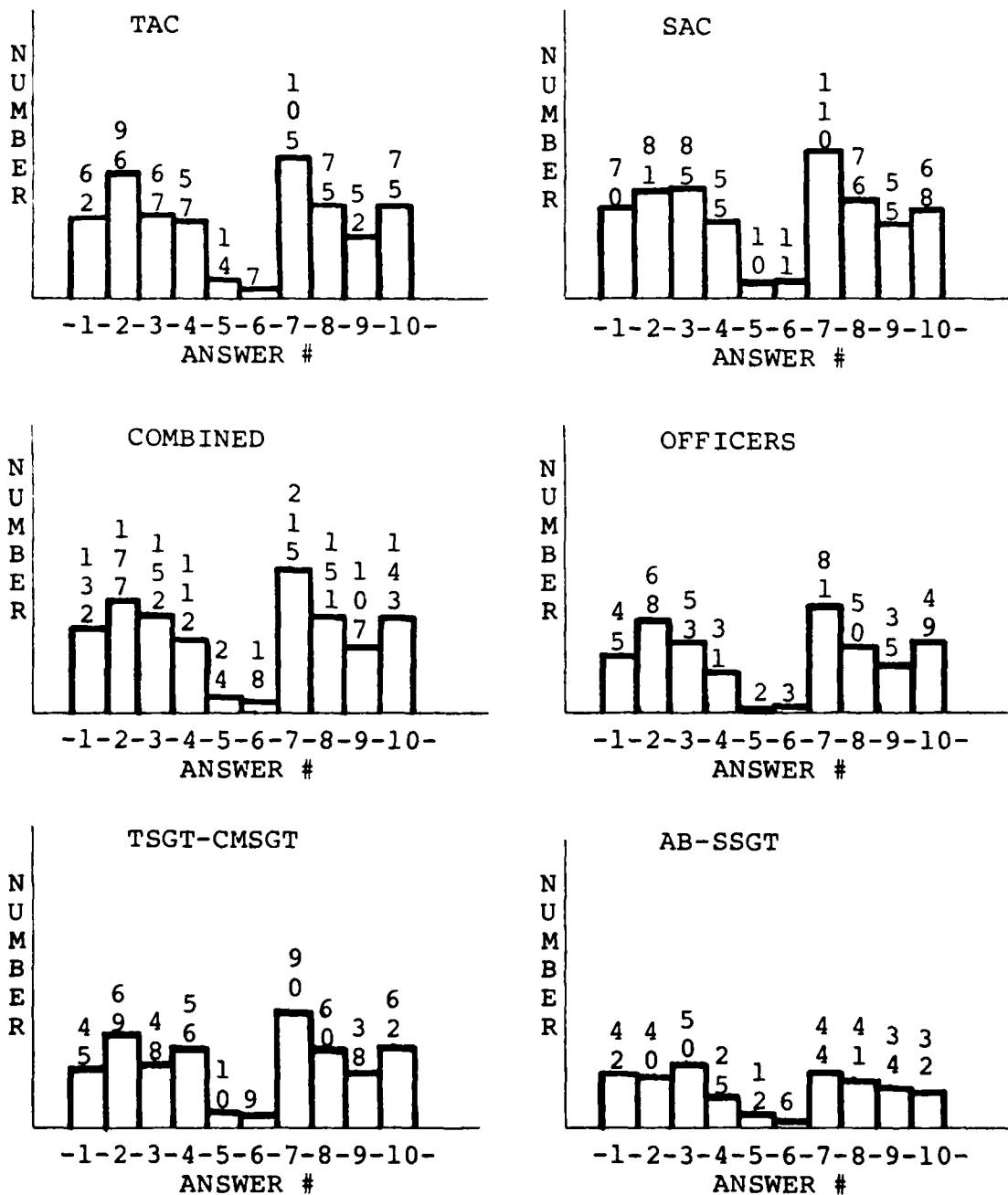
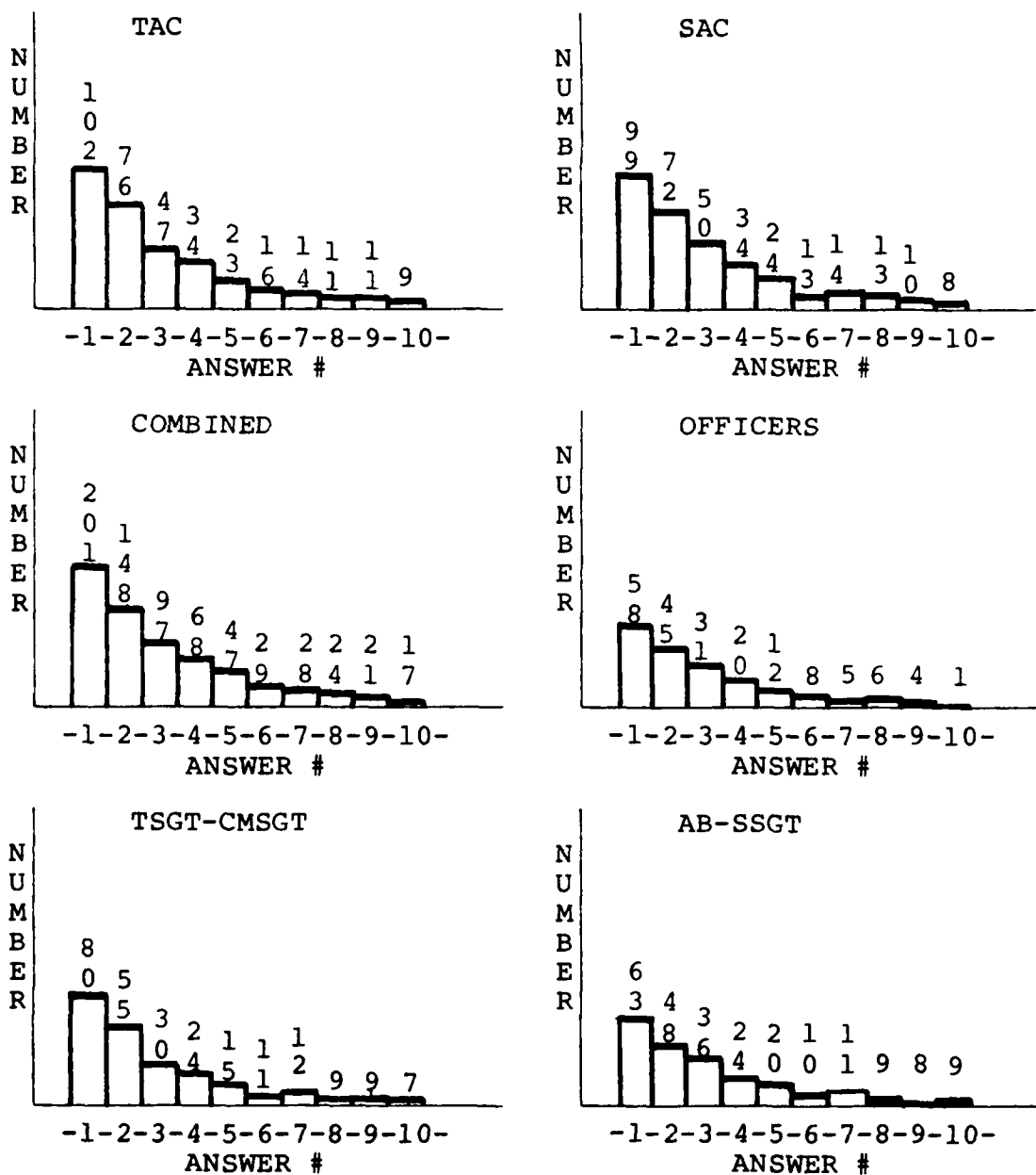


Fig. 3. Histograms of Responses to Question 15

QUESTION 18. What type of data on an AFTO Form 349 is most often reported in error:



- | | | | |
|---|------------------|----|--------------------|
| 1 | Start/stop times | 6 | ID numbers |
| 2 | Work unit code | 7 | Type maintenance |
| 3 | How mal code | 8 | When discovered |
| 4 | Action taken | 9 | Job control number |
| 5 | Crew size | 10 | Category of labor |

Fig. 4. Histograms of Responses to Question 18

in this manner felt that CAMS would provide improved capabilities for collecting and processing maintenance data. They felt this new system would simplify procedures for documenting and reporting the data collected by the current MDC system. Furthermore, they felt that CAMS would enable mechanics and base-level managers to access the data from remote terminals located in their work centers therefore making it possible to use the information in their daily jobs.

The second recommendation for changing the current MDC system was to simplify the existing system. Many people felt that the AFTO Form 349 is too complicated requiring numerous codes and the interpretation of too many rules on how to properly fill it out. Respondents felt that there needs to be a way to correct data if it has been entered incorrectly. Requirements for data need to be validated and data not needed should no longer be collected. A simple, less time-consuming system is what they would like to see.

The third recommendation for changing the system was to remove time accounting from the MDC system. Respondents felt that so much emphasis is placed on man-hour documentation that personnel do not attempt to accurately document the maintenance that was actually accomplished. Personnel just feel the pressure to account for eight hours a day.

The next recommendation was to broaden and redesign the code manuals to make it easier to document any type of maintenance that occurs. They felt that too often maintainers have difficulty in finding the correct codes so they just use the one that looks the closest or one that the system accepted on a previous occasion. Furthermore, many respondents felt that it is too time-consuming to dig through the current code manuals to document maintenance actions.

The last recommended change reported here is the recommendation to abolish the MDC system entirely. Respondents felt that the MDC system is cumbersome, inaccurate, and ineffective. They felt that benefits derived from this system were far outweighed by the tremendous cost, both in manpower and dollars, of operating this outdated system.

Question 17 asked: "What do you feel is the single most prevalent reason for errors occurring in the MDC data base?" The answers were reviewed and put into several categories.

The most common answer given to this question was that errors most often occurred because personnel failed to take the necessary time to fill out the paperwork right. People are apathetic about the MDC system and this results in a general inattention to detail when documenting maintenance actions. One hundred and twenty-seven respondents

replied in this manner, which is one third more than the next closest category.

A general lack of training on and understanding of the MDC system was the next most common reason given. Ninety-six of those responding felt that this lack of knowledge due to inadequate training was the cause of most errors. Fifty-eight respondents felt that plain mistakes in filling out the AFTO Form 349 or the inability to read the 349s resulted in most of the errors in the MDC data base.

The fourth most prevalent reason given for errors in the MDC data base was that pressure to account for 100 percent of the man-hours assigned to a unit resulted in the falsification of inputs and, therefore, errors in the data base. There appears to be a widespread belief that MDC data is used directly in determining manning levels and this has resulted in the belief that manning can be boosted by merely documenting an excess of maintenance. Fifty-six people responded in this manner. Fifty people responded that keypunch errors was the most prevalent reason for the errors in the data base. Twenty-seven people felt that the -06 Work Unit Code manual was either too complicated or did not cover all of the situations they faced and, therefore, resulted in errors being input to the data base.

Question 19 asked: "If you know of any person(s) who intentionally inputs false data into the MDC system, what are the top three most common reasons given for their actions?" The overwhelming response to this question was the pressure from superiors to account for 100 percent of their man-hour availability. A total of 218 people responded in this manner. This was two and a half times greater than the second most common answer.

The second most common answer was that personnel felt they were not given (or failed to take) adequate time to accomplish their documentation paperwork. Eighty-eight people responded in this manner. The third most common answer, with fifty-four responses, was to show overtime worked (whether it actually was or not) in an attempt to gain additional manning.

The remaining responses to this question were as follows:

Lack of training on documentation	36
Unable to find correct information in T.O.	29
Perception that nobody uses the data	29
They forgot the correct information	16
To show that some repair action was taken rather than document a Could Not Duplicate discrepancy (especially for a repeat or recurring write-up)	6
To document to meet the job standard	3
Peer pressure	3

The results presented in this chapter will be analyzed in the chapter which follows.

V. Analysis, Conclusions, and Recommendations

The results presented in the previous chapter will be analyzed here to determine the answers to the investigative questions. The results of this analysis will determine the degree to which the research objective was accomplished. Recommendations will then be made for future maintenance data collection efforts in the Air Force and further research into this subject area.

Investigative Question 1

Is inaccurate or invalid data intentionally input into the MDC system? If so, for what reason or reasons, how often, and to what extent?

The answer to the first part of this investigative question is found by examining the responses to survey questions 11, 12, 13, and 14. Question 11 states: "Maintenance personnel are pressured by superiors to manipulate the MDC input." The actual responses to this statement ranged from always, with a value of 1, to never, with a value of 5. The mean response was calculated to be 3.123 with a .969 standard deviation. The modal response was 3. This response was the "sometimes" reply to the statement and would correspond to the midpoint on the scale from always to never.

Question 12 on the survey states: "The majority of inaccurate and invalid data that is input to the MDC system is caused by: (1) Key punch errors; (2) Errors in filling out 349's; (3) Manipulation of the input to meet expectations; (4) Computer malfunctions; (5) Other (Please specify)." The modal response to this statement was 2 with 284 respondents replying in this manner. The second most cited response was 3 with 166. While response 2 accounted for over one half of all replies as expected, nearly one third of the respondents feel that data manipulation causes the majority of inaccurate and invalid MDC data inputs. As a note, of those citing 5 as their choice, the responses given most often were: (5a) Not taking the time to do it correctly, failure to be complete and thorough; (5b) Not enough information in the -06 Work Unit Code manual and it is too difficult to use; (5c) Pressure to account for 100 percent of available man-hours; and (5d) Poor penmanship resulting in keypunch errors.

Question 13 states: "In your opinion, what percentage of the data input into the MDC system is accurate concerning maintenance actions that occurred?" While the choices in responses ranged from 0% (1) to 100% (11), nobody answered that the input was totally inaccurate. The mean response to this question was calculated to be 7.354 with a standard deviation of 2.028. This means that maintenance personnel feel that only 63.54 percent of the data

input into the MDC system is accurate. Only six respondents felt that inputs were 100 percent accurate.

Question 14 states: "Of the data that is input into the MDC system that is inaccurate, what percentage of that inaccurate data is intentionally inaccurate?" The mean response was 3.520 with a 2.458 standard deviation. This translates into 25 percent. Maintenance personnel feel that one fourth of the data which is input inaccurately, is done so intentionally.

From examining the responses to these four questions, the answer to the first part of this investigative question becomes apparent. Intentionally inaccurate and invalid data is input into the MDC system. Now we will focus on the second portion of this investigative question. This will be answered by examining the responses to questions 8, 10-14, and 17-19.

Question 8 states: "Inaccurate data is input to the MDC system due to the difficulty coding the information on the AFTO Form 349." Answers to this question ranged from strongly agree (1) to strongly disagree (5). The mean response was determined to be 2.662 with a standard deviation of 1.062. The modal and median response was 2. Maintenance personnel agree, though only slightly, that difficulty in properly coding the AFTO Form 349 is a cause for the input of inaccurate data into the MDC system.

Question 10 of the survey stated: "Correct and valid data is input into the MDC system by maintenance personnel." Responses to this statement ranged from always (1) to never (5). The mean response was calculated to be 2.54 with a .739 standard deviation. The modal response was 2, while the median was 3. Maintenance personnel, in general, seem to feel that correct and valid data is input into the MDC system between "sometimes" and "usually." This answer correlates well with the answers given to question 13 mentioned earlier in which respondents felt that 63.54 percent of the data input is accurate concerning maintenance actions that occurred.

Questions 11 and 12 were analyzed earlier. Questions 13 and 14, when their responses are combined, show that maintenance personnel feel that approximately 10 percent of all data input into the MDC system is intentionally inaccurate and invalid. Questions 17 through 19 were summarized in the previous chapter.

Upon review of the responses to these eight questions, the second part of investigative question 1 can be answered. Inaccurate and invalid data is intentionally input into the MDC system. It is the consensus of those surveyed that nearly 10 percent of all data input is intentionally inaccurate. The reason cited most often for this intentional input of inaccurate or invalid data is the pressure from supervisors and managers to account for

100 percent of their man-hour availability. This is reflected in the responses to the question asking respondents to cite the type of data on an AFTO Form 349 which is most often reported in error. The highest ranked response was the start and stop times for maintenance actions.

Investigative Question 2

What is the perceived value of the MDC information at the operating base level?

The answer to this investigative question can be found through an examination of the responses to survey questions 5, 6, 7, 9, 15, and 16. Question 5 of the survey states: "The Maintenance Data Collection (MDC) system provides valuable information for base-level managers." The responses to this and the next three questions ranged from strongly agree (1) to strongly disagree (5). The mean response to question 5 was calculated to be 2.615 with a standard deviation of 1.034. The median and the mode was 2. Maintenance personnel slightly agree that MDC provides valuable information for base-level managers.

Question 6 states: "The MDC system provides timely feedback for base-level managers." The mean response was 3.051 with a 1.067 standard deviation. The modal response was 2 and the median was 3. Maintenance personnel neither agree nor disagree that MDC provides timely feedback for base-level managers.

Question 7 of the survey states: "The MDC system provides an accurate accounting of man-hour utilization in the maintenance complex." The mean was calculated to be 3.636 with a standard deviation of 1.086. The median and the modal response was 4. Maintenance personnel do not feel that MDC provides an accurate accounting of man-hour utilization in the maintenance complex.

Question 9 states: "The MDC system is a useful management tool which should be retained by the Air Force." The mean response was 2.885 with a standard deviation of 1.130. The modal response was 2 and the median was 3. Maintenance personnel only slightly agree that the MDC system is useful enough to be retained by the Air Force as a management tool.

Question 15 asked respondents to choose from a list of ten words or phrases those which best describe the present MDC system. The responses were as follows, ranked from most to fewest: flawed, slow, useful, tedious, error laden, helpful, waste of time, worthwhile, efficient, accurate. While 215 chose "flawed" and 177 chose "slow" to describe the present MDC system, only 24 chose "efficient" and a mere 18 chose "accurate." Maintenance personnel have little confidence in the present MDC system.

Question 17 was an open-ended question which asked: "If it were in your power to change the MDC system, what changes would you make and why?" The responses to this

question were summarized in Chapter IV. The majority of respondents expressed the need for a simpler, faster maintenance data system that is capable of having outputs tailored to fit the needs of the individual manager. Many hoped that the CAMS data collection system would be implemented as soon as possible.

The responses to these questions collectively answer investigative question 2. Maintenance personnel feel that the data collected is important for base-level managers but the current MDC system is much less than ideal. They see the data base as being full of inaccuracies and invalid inputs. They feel the current system is flawed, slow and tedious. They would like to see changes made to make the system quicker and more user oriented.

Investigative Question 3

Are the findings consistent between workers, supervisors, and managers? Between major commands?

The answer to this investigative question was found by doing an analysis of variance on questions 5-11, 15 and 16 with the responses broken out first by MAJCOM and then by workers (airman basic to staff sergeant), supervisors (technical sergeant to chief master sergeant), and managers (officers). The analysis of variance was accomplished to determine if the groups had significantly different responses at a .05 level of significance.

Differences were found to exist primarily in the subgroupings of worker, supervisor and manager. All but one of the questions tested showed significant differences in answers between these categories. On question 5, the level of agreement that MDC provides valuable information for base-level maintenance managers declined as rank increased. The same relationship existed on questions 6 and 7. On question 9, the usefulness of the MDC system as a management tool was ranked highest by workers, then managers, and lowest by supervisors. This same relationship existed on question 10 concerning the input of correct and valid data into the MDC system by maintenance personnel. Supervisors expressed the highest level of agreement to question 11 that maintenance personnel are pressured by superiors to manipulate the MDC input. Managers had the lowest level of agreement with this statement. Question 15 asked respondents to estimate the level of accuracy of inputs to the MDC system. Workers and managers expressed the accuracy as being significantly higher than did the supervisors. The level of intentional input of inaccurate data was estimated in question 16 with workers and supervisors saying a significantly higher amount occurred than did managers. Question 10 was the only question that showed a significant difference between the two major commands surveyed.

Conclusions

The evidence gathered in this research points to a previously unreported level of intentional input of inaccurate and invalid data into the MDC system. Those surveyed indicated that nearly 10 percent of all data input is intentionally inaccurate. Over 85 percent of those surveyed felt that some of the data which is input inaccurately is intentionally input in that manner. The pressure to account for man-hour availability is the primary reason given for falsifying the MDC input. Ninety-two percent of the maintenance personnel surveyed admitted that they are pressured at least part of the time to manipulate the MDC input.

The input of less than full and accurate data amounts to a breach of integrity on the part of those inputting that information. This breach of integrity should be viewed as totally unacceptable by supervisors and managers at all levels. The reasons given for these actions point to supervisory pressure as the principal cause. Supervisors and managers, whether wittingly or not, are creating situations that in effect coerce subordinates to sacrifice both the accuracy of the MDC system and their integrity.

Recommendations

Leadership at all levels of the Air Force maintenance complex needs to re-evaluate its motives and

methods for insuring maintenance information is input into the MDC system. Maintenance personnel seem to be willing to give the boss whatever he wants, even if it means altering the facts to do so.

The information reported in this study indicates that further research should be conducted into the amount and types of data that need to be collected from Air Force maintenance organizations. Personnel feel overburdened documenting maintenance tasks to the level currently required. An unacceptable amount of the data being documented is being "pencil-whipped," especially in the area of time accounting.

The Air Force should consider a maintenance data collection system similar to that used by the U.S. Army and described by Army Pamphlet 700-24, Sample Data Collection (SDC). The SDC system replaced a total data collection system which had been used by the Army until 1970. The previous system was done away with because the data collection put a heavy burden on the troops, the data was unreliable, the cost was too high, and the volume of data was unmanageable. The SDC system is a method of selective sampling of specific equipment items. Collection of data is done for a specific period of time on a specific kind of equipment in specific units. The requester of the data must initially justify the need for the performance data.

Then, annually, the requester must show documentation of how that data was used to meet previously stated objectives.

A system similar to this could save the Air Force millions of dollars annually while reducing the paperwork burden on maintenance personnel. A study into the feasibility of such a system would be beneficial to the Air Force and should be accomplished prior to complete implementation of CAMS.

Appendix A: Definitions

ATLAS Database--the central computer data base at Randolph AFB, Texas, which is used by the Air Force to manage active duty and reserve personnel records.

Configuration Status Accounting--the reporting and recording of changes made to the initial approved configuration of the system/item as it is programmed for operational use, in order to establish an official USAF documented indication of the actual configuration of a serial numbered system or equipment at a given time in relation to an approved configuration.

Direct Labor--productive hours expended on on-equipment and off-equipment maintenance.

Discrepancy--the inability of an item to perform within previously specified limits.

Indirect Labor--productive indirect hours expended for leave, details, compensatory time off, training, and alert duty.

Maintainability--a characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources.

Off-equipment Maintenance--repair and work on assemblies, subassemblies, or components apart from an end item of equipment.

On-equipment Maintenance--this includes support general work (accomplishment of scheduled and special inspections), removal and replacement of components, and fix-in-place repair actions. Repairs accomplished in the vicinity of the end article on components removed for the convenience of making repairs or requirements for installation preparation are also considered to be on-equipment work. Removal and replacement of complete engines in aircraft, air launched missiles, and support equipment (SE) are considered to be on-equipment work with the engine considered as component. After removal and during in-shop work, aircraft engines and SE gas turbine engines are considered to be end articles and the on-equipment/off-equipment concepts apply.

Operating and Support Costs--all costs associated with operating the weapon system from delivery to retirement.

Reliability--the probability that an item will perform its intended function for a specified interval under stated conditions.

Appendix B: Survey Package

LS (Capt Folmar, AU 785-6569)

Maintenance Data Collection Survey Package

1. Please take the time to complete the attached questionnaire and return it to us in the enclosed envelope within the next two weeks, if possible, but not later than 23 May 1986.
2. The survey measures your perceptions and attitudes toward the current Maintenance Data Collection system. The data we gather will become part of an AFIT research project and may influence the design of future data collection systems if significant design flaws are uncovered.
3. Your individual response will be combined with others and will not be attributed to you personally. Your identity will remain completely anonymous.
4. Your participation in this research effort is completely voluntary, but we would certainly appreciate your help.

LARRY L. SMITH, Colonel, USAF
Dean
School of Systems and Logistics

2 Atch
1. Questionnaire
2. Return Envelope

USAF Survey Control Number 86-41, expires 31 Dec 86

MAINTENANCE DATA COLLECTION
SURVEY INSTRUCTIONS

1. Do not write your name or your social security number on the survey questionnaire. All replies will be completely anonymous.
2. Read all questions carefully and circle the appropriate answer(s). Answer all questions to the best of your knowledge.
3. On the open ended questions, write your answers in the space provided. If more space is required, please attach any additional sheets required.
4. Upon completion, please place your survey in the attached envelope and place the envelope in base distribution.
5. Please try to return the survey within two weeks so that we may get the results published by the end of summer.
6. Thank you for your time and cooperation.

Section I. Background Information

This section contains several items dealing with personal characteristics. This information will be used to describe the population of the study.

1. You are assigned to which major command:
 - (1) Tactical Air Command
 - (2) Strategic Air Command
2. Your rank is: _____
3. (OPTIONAL) Your current duty title is: _____
4. You have worked in an aircraft maintenance career field for how long? _____

SECTION II. Please respond to the following statements as honestly and openly as possible.

5. The Maintenance Data Collection (MDC) system provides valuable information for base-level maintenance managers:

(1)	(2)	(3)	(4)	(5)
Strongly	Agree	Neither Agree	Disagree	Strongly
Agree		nor Disagree		Disagree

6. The MDC system provides timely feedback for base-level maintenance managers:

(1)	(2)	(3)	(4)	(5)
Strongly	Agree	Neither Agree	Disagree	Strongly
Agree		nor Disagree		Disagree

7. The MDC system provides an accurate accounting of man-hour utilization in the maintenance complex:

(1)	(2)	(3)	(4)	(5)
Strongly	Agree	Neither Agree	Disagree	Strongly
Agree		nor Disagree		Disagree

8. Inaccurate data is input to the MDC system due to the difficulty in accurately coding the information on the AFIO Form 349:

(1)	(2)	(3)	(4)	(5)
Strongly	Agree	Neither Agree	Disagree	Strongly
Agree		nor Disagree		Disagree

9. The MDC system is a useful management tool which should be retained by the Air Force:

(1)	(2)	(3)	(4)	(5)
Strongly	Agree	Neither Agree	Disagree	Strongly
Agree		nor Disagree		Disagree

10. Correct and valid data is input into the MDC system by maintenance personnel:

- | | | | | |
|--------|---------|-----------|--------|-------|
| (1) | (2) | (3) | (4) | (5) |
| Always | Usually | Sometimes | Seldom | Never |

11. Maintenance personnel are pressured by superiors to manipulate the MDC input:

- | | | | | |
|--------|---------|-----------|--------|-------|
| (1) | (2) | (3) | (4) | (5) |
| Always | Usually | Sometimes | Seldom | Never |

12. The majority of inaccurate and invalid data that is input to the MDC system is caused by:

- (1) Key punch errors
- (2) Errors in filling out 349's
- (3) Manipulation of the input to meet expectations
- (4) Computer malfunctions
- (5) Other (Please Specify)

13. In your opinion, what percentage of the data input into the MDC system is accurate concerning maintenance actions that occurred?

- | | |
|----------|------------|
| (1) 0 % | (7) 60 % |
| (2) 10 % | (8) 70 % |
| (3) 20 % | (9) 80 % |
| (4) 30 % | (10) 90 % |
| (5) 40 % | (11) 100 % |
| (6) 50 % | |

14. Of the data that is input into the MDC system that is inaccurate, what percentage of that inaccurate data is intentionally inaccurate?

- | | |
|----------|------------|
| (1) 0 % | (7) 60 % |
| (2) 10 % | (8) 70 % |
| (3) 20 % | (9) 80 % |
| (4) 30 % | (10) 90 % |
| (5) 40 % | (11) 100 % |
| (6) 50 % | |

15. Which of the following words best describe the present MDC system: (Circle all that apply)

- | | |
|-------------------|------------------|
| (1) Helpful | (6) Accurate |
| (2) Slow | (7) Flawed |
| (3) Useful | (8) Tedious |
| (4) Waste of time | (9) Worthwhile |
| (5) Efficient | (10) Error laden |

16. If it were in your power to change the MDC system, what changes would you make and why? PLEASE BE AS SPECIFIC AS POSSIBLE.

17. What do you feel is the single most prevalent reason for errors occurring in the MDC data base?

18. What type of data on an AFTO Form 349 is most often reported in error?

19. If you know of any person(s) who intentionally inputs false data into the MDC system, what are the top 3 most common reasons given for their actions?

Please feel free to use the remaining space to comment on the advantages, disadvantages, problems, or other important aspects of the Maintenance Data Collection system as you perceive it.

THANK YOU FOR YOUR COOPERATION

Appendix C: Data Table

The data received on the survey questionnaires was coded and input to the ASC computer for analysis using SPSS-X statistical software. The data on the following pages reflect the following information from the surveys:

Survey Number	<u>Field #</u>
Question 1	1 - 3
Question 2	4
Question 4	5 - 6
Question 5	7 - 8
Question 6	9
Question 7	10
Question 8	11
Question 9	12
Question 10	13
Question 11	14
Question 12 (Answer 1)	15
(Answer 2)	16
(Answer 3)	17
(Answer 4)	18
(Answer 5)	19
Question 13	20
Question 14	21 - 22
Question 15 (Answer 1)	23 - 24
(Answer 2)	25
(Answer 3)	26
(Answer 4)	27
(Answer 5)	28
(Answer 6)	29
(Answer 7)	30
(Answer 8)	31
(Answer 9)	32
(Answer 10)	33
	34

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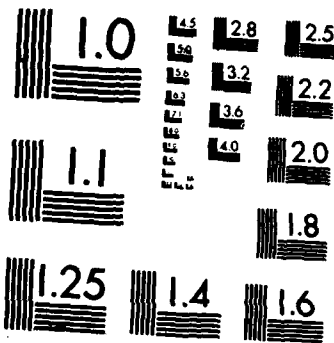
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Vita

Captain Thomas L. Folmar was born on 14 March 1956 in Miami, Florida. He graduated from high school in Spring City, Tennessee, in 1974 and attended the University of Tennessee from which he received the degree of Bachelor of Science in Business Administration in August 1978. Upon graduation, he received a commission in the USAF through the ROTC program. He was called to active duty in June 1979 and completed the Aircraft Maintenance Officer course at Chanute AFB in February 1980. He served as an aircraft maintenance officer at the 31st Tactical Training Wing, Homestead AFB, Florida until May 1982. He then served as a Maintenance Supervisor at the 513th Tactical Airlift Wing, RAF Mildenhall, England until January 1984. He then served as the EC-135 Branch OIC where he completed a Master of Business Administration from Embry-Riddle Aeronautical University in June 1984. In May 1985, he entered the School of Systems and Logistics, Air Force Institute of Technology, pursuing a Master of Science degree in Logistics Management (Maintenance Management Option).

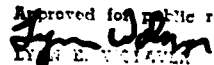
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<p>Title: INTENTIONAL INPUT OF ERRORS INTO THE MAINTENANCE DATA COLLECTION SYSTEM</p> <p>Thesis Chairman: Paul A. Reid, Lieutenant Colonel, USAF Instructor of Logistics Management</p> <p style="text-align: right;">Approved for public release: IAW AFR 180-1.  24 SEP 86 Lt. Col. Paul A. Reid Director for Research and Professional Development Air Force Institute of Technology (2204) Wright-Patterson AFB OH 45433</p>				
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This research attempted to quantify the perceived magnitude of intentional errors in the Maintenance Data Collection system data base and to determine the underlying causes for the reporting of inaccurate and invalid data. It was limited to the aircraft maintenance organizations within the Strategic Air Command and the Tactical Air Command. A stratified random sample was surveyed of all aircraft maintenance personnel of the rank of airman basic through colonel in the aircraft maintenance complex at the bases in these two commands within the continental United States.

Those surveyed indicated that nearly 10 percent of all data input is intentionally inaccurate. Over 85 percent of those surveyed felt that some of the data which is input inaccurately, is done so intentionally. The pressure to account for man-hour availability is the primary reason given for falsifying the MDC input. Ninety-two percent of the maintenance personnel surveyed admitted that they are pressured at least part of the time to manipulate the MDC input.

A recommendation was made for the leadership at all levels of the Air Force maintenance complex to re-evaluate their motives and methods for insuring maintenance information is input into the MDC system. Furthermore, the information uncovered in this study indicates that further research should be conducted into the amount and types of data that need to be collected from Air Force maintenance organizations. The Air Force should consider a maintenance data collection system similar to that used by the U.S. Army (the Sample Data Collection system).

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